attained, viz., it should be *correct* so far as it goes and so far as existing knowledge permits; it should be *concise*, *consistent* and, above all things, CLEAR.

For use in systematic instruction the textual form of a scientific manual should be neither that of a treatise to be perused nor that of a lecture to be spoken. The paragraphs should be short, categoric and visibly, as well as logically, coordinated and subordinated.

It is probable indeed that one of the grounds for the success of mathematics and linguistics as disciplinary studies is the relative perfection of their pedagogic methods, and especially the way in which the general rules and exceptions thereto are set forth.

As to the *writer of a text-book*, if the book fulfills the requirements perhaps its source is of little moment. But even if this be not conceded I fear the limitation indicated by Prof. Gage is practically unattainable. With the absolute convictions natural to comparative youth, he is perhaps so sure that "a little knowledge is a dangerous thing" as to forget that, if that pithy saying be strictly true, no one of us can regard himself as altogether safe. Indeed, it is now many years since any one person could obtain *all* physiologic information at first hand. I trust, therefore, that Prof. Gage may assent to this less stringent statement: The writer of a text-book should have made some real contribution to physiologic method, fact or idea.

Like the teacher, the writer of a text-book needs to guard against the temptation to subordinate the needs and capacities of the learner to the supposed necessity for exhibiting his own erudition. The wisest of teachers is he who knows just what to omit.

In general method there is too often a direct inversion of the natural order. Children should be led to sing before they talk; they should be taught to draw before they write; and they should be encouraged to *observe* before they are compelled to think. In observing and reflecting they should be neither pushed nor pulled, but guided.

As applied to physiologic instruction, instead of '*verba et præterea nihil*,' or even many words illustrated by a few random demonstrations, there should be numerous and well devised experiments upon which the pupils should reflect and comment. In short, in the place of what may be called *inducation* there should be sought a true *education*. Contrary to the Scripture phrase, the kingdom of science cometh *with observation*.

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GEOLOGICAL ATLAS OF THE UNITED STATES.

FOLIO 16, KNOXVILLE, TENNESSEE–NORTH CAROLINA, 1895.

THIS folio, by Arthur Keith, consists of six pages of text, a topographic sheet, a sheet showing the areal geology, another showing the economic geology, a third giving structure sections, and a fourth giving columnar sections. The folio describes that portion of the Appalachian province which lies between parallels 35° 30′ and 36° and meridians 83° 30′ and 84°. This district contains about 968 square miles, divided between Knox, Sevier, Bland and Jefferson counties, in Tennessee, and Swain county, in North Carolina.

The text begins with a general description of the province, and shows the relation of this part to the whole. The local features of the drainage by the Holston, Tennessee and Little Tennessee Rivers and their tributaries, such as the Little Pigeon and Little Rivers, follow next in description. The various forms of the surface are pointed out, such as East Tennessee Valley, Smoky Mountains and Chilhowee Mountain, and their relations to the underlying rocks are emphasized.

Under the heading 'Stratigraphy' the

geologic history of the Appalachian province is presented in outline, and the local rock groups are fully described in regard to composition, thickness, location, variety and mode of deposition. The formations range in age from Algonkian (?) to Silurian, the greater portion being Algonkian (?). The Silurian rocks appear in the East Tennessee Valley, the Cambrian in Chilhowee Mountain and in various narrow belts in the valley, and the Algonkian southeast of Chilhowee Mountain. The Algonkian rocks are chiefly slates, sandstones, conglomerates and graywackes; the Cambrian rocks consist of sandstones and shales in the Chilhowee belt and of sandstones, shales and limestones in the valley; the Silurian rocks comprise sandstones, limestones and shales. The details of the series of strata are shown in the columnar section. The process of decay in each kind of rock is discussed, and the manner in which the residual soils and forms of surface depend on the nature of the underlying rock.

In the discussion of 'Structure,' after a general statement of the broader structural features of the province, two methods are shown in which the rocks have been deformed. Of these the extreme Appalachian folding is the chief, and less in importance are the broad vertical uplifts. Three degrees of deformation appear in the Paleozoic rocks—folding, faulting and metamorphism—each being best developed in certain kinds of strata. The region northwest of Chilhowee Mountain is broadly anticlinal, while the Smoky Mountain district is synclinal, and two lines of minor uplift appear in each of these districts. Faults are found chiefly on the west side of these minor uplifts, especially in the Cambrian sandstones, and metamorphism increases southeast from Chilhowee Mountain. In the East Tennessee Valley the rocks are folded to an extreme degree and the strata are frequently perpendicular or overturned. In the sheet of sections the details of the folds and faults appear.

Economic products of this region comprise gold and iron ore, ornamental stone, such as marble, such building stone as sandstone, limestone and slate, and other materials, like lime, cement and brick clay. The localities of each of these materials are noted, and quarries are located on the economic sheet, and the nature and availability of the deposits are discussed. The resources of the region which inhere in timber and water power are also described.

FOLIO 19, STEVENSON, ALABAMA-GEORGIA-TENNESSEE, 1895.

This folio, by Charles Willard Hayes, is bounded by parallels 34° 30′ and 35° and meridians 85° 30′ and 86°. It contains 980 square miles, embracing portions of Franklin and Marion counties in Tennessee; Dade, Walker and Chattooga in Georgia; and Jackson, Dekalb and Cherokee in Alabama. The folio contains four pages of text, including a generalized columnar section and four coal sections; one sheet showing topography, another showing areal geology, a third economic geology and a fourth giving five structure sections inserted in the map.

The Stevenson quarter degree is occupied chiefly by the Cumberland plateau and its outliers, Sand and Lookout Mountains. It includes also a portion of Brown's Valley, which is the southward continuation of Sequatchie Valley and is located upon the westernmost of the sharp anticlines which characterize the folded belt of the Appalachians. Extending diagonally across the center of the area is a broad, level plateau, forming Sand Mountain. It is bounded by straight and steep escarpments. To the east are Lookout and Wills valleys, also located upon sharp anticlines. Finally, the southeastern portion of the area is occupied by Lookout Mountain, also a broad, level pla-

teau. Thus there is seen to be a close relation in this region between structure and topography. The valleys are located upon the anticlines and the plateaus coincide with the synclines. This relation depends upon the relation of hard and soft rocks in this region. Of the strata exposed, the upper formations are hard sandstones and the lower generally limestones. After the anticlinal folds had been produced by lateral pressure the region was for a long time subjected to subaëreal erosion. The whole surface was reduced to a nearly uniform plain, now represented by the summits of the plateaus, but then near sea level. Thus the hard sandstone was removed from the tops of the arches, and when the region was elevated the softer limestones there exposed were easily reduced to the lower level, while the surface within the synclines was protected from erosion by the hard sandstones.

The oldest formation of the region is the Knox dolomite, which is brought to light along the axes of the anticlines. Above this is the Chickamauga limestone, from 1,100 to 1,400 feet in thickness, and the Rockwood, which is here a calcareous shale. The Devonian is represented by black, carbonaceous shale from 20 to 40 feet in thickness, and the Carboniferous by Fort Payne chert and Bangor limestone, representatives of the Mississippian series, and the Lookout and Walden sandstones, forming the coal measures. In all about 5,000 feet of strata are exposed, and the formations generally thicken toward the southeast.

The structure of the region is quite simple, and has already been indicated. In addition to the anticlines which were mentioned, there is a fault along the western side of the Sequatchie anticline which brings the Knox dolomite in contact with the Bangor limestone for several miles.

The principal mineral resources of the region are coal and iron ore, while limestone, building and roadstone and brick and tile clay are subordinate but important. The coal-bearing formations are the Lookout and Walden. They occupy the surface of the plateaus, forming 544 square miles, the larger portion of which probably contains workable coal. The only important development of the coal is in Dade county, Georgia, where five beds occur below the conglomerate, at least four of which are workable locally. The chief iron ore of the region is red hematite or fossil ore of the Rockwood formation. This ore is very similar in appearance to that occurring at the same horizon in such widely separated localities as Wisconsin, New York and central Alabama. It has been extensively worked in the vicinity of Rising Fawn, near the Georgia-Alabama line. It is not always of workable thickness, but the economic map shows the areas within which it may be found.

FOLIO 20, CLEVELAND, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, embraces 4 pages of text, a sheet showing topography, another areal geology, and a third economic geology, also a sheet containing five structure sections, and, finally, a sheet giving two generalized stratigraphic sections.

The Cleveland quarter-degree is bounded by the parallels 35° and 35° 30′ and the meridians 84° 30′ and 85°. It contains 975 square miles, including portions of Meigs, McMinn, James, Bradley and Polk counties. The country represented on the Cleveland sheet lies largely in the Appalachian valley. Its northern corner reaches within two miles of the Cumberland escarpment, which forms the western limit of the valley district, while its southeastern corner reaches beyond the limit of the valley, and includes a small portion of the Unaka Mountains, which form the western chain of the Appalachians. When the valley

district is seen from an altitude of 1,000 feet or over, it appears as a broad undulating plain, nearly all the ridges and hills rising to a uniform level a little less than 1,000 feet in altitude. Above this level a few ridges rise some hundreds of feet; below it the Tennessee and Hiwassee Rivers flow in valleys 250 feet in depth. In other words, this portion of the Appalachian Valley may be regarded as a plain on which the higher ridges remain in relief and in which the stream channels have been sunk. A similar plain, having an altitude of about 1,700 feet, stretches along the western base of the Unaka chain. This is much more deeply dissected by narrow stream channels than the lower plain in the valley. These are portions of the two principal peneplains of the southern Appalachian province, formed respectively in Tertiary and Cretaceous time. The greater part of the area is drained by tributaries of the Hiwassee River, which crosses it in a direct course and joins the Tennessee River near the western border. A small part is drained by the Conasauga River, whose waters flow south to the Coosa and thence directly to the Gulf. The divide between the drainage systems is broad and indistinct, and a little below the lower of the two peneplains of the region. From a study of this and adjacent areas it appears probable that during the formation of that peneplain the drainage was very different from that at the present time. Previous to the uplift which caused the streams to cut their present channels in the peneplain, the Tennessee River did not turn westward, as it now does, but continued southward in the valley, across the present divide, directly to the Gulf.

The rocks of the Cleveland quarter-degree fall into three groups: The Ocoee series, the Chilhowee series, and the fossiliferous Paleozoic formations of the Appalachian Valley. Probably the oldest rocks in the region occur in its southeastern corner, forming Big Frog Mountain and the plateau along its western base. No fossils have yet been found in these rocks, and they are separated by a great fault from rocks of known age, so that their position in the stratigraphic column has not been fixed with certainty. However, since they bear all the marks of extreme age, and, so far as known, contain no organic remains, they will be considered Algonkian until satisfactory evidence to the contrary is found. They consist chiefly of graywacke slates, containing many beds of coarse conglomerate and some siliceous limestones.

The Chilhowee series consists of quartzites, sandstones, conglomerates and shales, which form Beans and Starrs Mountains at the southeastern border of the valley. The area of these rocks is separated by faults both from the Ocoee on the east and the fossiliferous valley formations on the west. No fossils have yet been found by which their age can be determined, but they correspond so closely with a series of formations in the Chilhowee Mountains, in which Cambrian fossils have been found, that there can be little doubt that they occupy the same stratigraphic position.

The fossiliferous Paleozoic rocks of the valley embrace three Cambrian formations, made up largely of argillaceous and sandy material. The Knox dolomite, which is from 3,800 to 4,100 feet in thickness, is in part Cambrian and in part Silurian. Above this is the Chickamauga limestone, 1,000 feet in thickness in the western part of the area, and 300 or 400 feet thick in the eastern part, where the upper portion of the limestone is replaced by shales and sandstones, forming the Athens, Tellico and Sevier formations. Finally, above these, is the Rockwood formation, which also shows considerable increase in thickness and in the proportion of coarse material toward the southeast. The Devonian is repre-

sented by 15 to 30 feet of black shale, and the Carboniferous by about 350 feet of very siliceous limestone.

The peculiar structures which characterize the intensely folded belt of the Appalachian Valley are highly developed in this region. The sections show five well-marked synclines west of the Ocoee rocks, with a large number which are less distinct. They are all nearly parallel, crossing the tract in a northeast-southwest direction with slightly curved axes. These synclines usually have gentle dips on their western sides and steep or overturned dips on their eastern. In most cases adjacent synclines are separated by thrust faults. Thus the strata are broken into a large number of narrow blocks which overlap each other, the fault plains all dipping southeastward.

The principal mineral resources of the region consist of iron ore, lead ore, limestone, building and road stone, and brick and tile clay. A small amount of hematite or red fossil ore occurs associated with the shales of the Rockwood formation. Also considerable bodies of limonite occur, chiefly along the great thrust faults which separate the Chilhowee series from the valley rocks. The lead ore is found in limestones at the base of the Knox dolomite, and is mined to some extent a few miles south of Cleveland.

FOLIO 21, PIKEVILLE, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, consists of 3½ pages of text, a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, another of structure sections, and a final sheet giving a generalized columnar section of the district and vertical sections showing the position and thickness of coal beds.

The quarter-degree covered by this folio has an area of 980 square miles. Its southeastern corner is just within the great Appalachian Valley, and its northwestern corner occupies a portion of the highland rim of Middle Tennessee. It therefore extends entirely across the Cumberland Plateau, whose level surface has here an elevation of about 1,700 to 2,000 feet above tide. The plateau is intersected by Sequatchie Valley, a narrow depression between wall-like escarpments which are parallel with the eastern escarpment of the plateau. This remarkable valley is located upon the westernmost of the sharp anticlinal folds which characterize the great Appalachian Valley belt. The western escarpment of the Cumberland Plateau is extremely irregular, being deeply notched by the streams flowing from its surface.

The two most important peneplains of the southern Appalachians are well developed in this region; the higher and older appears in the surface of the plateaus, and the younger, about 1,000 feet below, forms the hilltops of the Sequatchie Valley and the surface of the highland rim.

The larger part of the surface of the Pikeville quarter-degree is occupied by Carboniferous rocks, the coal measures (Walden and Lookout sandstones) forming the surface of the plateaus, while the Bangor limestone and Fort Payne chert occupy the lower slopes of the escarpments and highland rim to the west. The underlying Devonian and Silurian formations are brought to light by the steep folds of the Sequatchie and Tennessee Valleys. The Devonian is represented by fifteen feet of carbonaceous shale which appears to be entirely conformable with the formations above and below.

Three Silurian formations are represented on the map. The Rockwood, at the top, is composed of sandstone and sandy shale in the Tennessee Valley, but becomes more calcareous toward the west, so that in the Sequatchie Valley it is a shaly limestone, and on the next quarter-degree is indistinguishable from the massive Chickamauga limestone below.

Compared with the Appalachian Valley belt to the east, the structure of this region is simple. Its most striking features are the Sequatchie anticline and fault. On either side the strata are nearly horizontal, forming a broad, shallow syncline on the east, and passing westward with a few low undulations into the great expanse of horizontal strata of the Mississippi Basin.

The most important economic interest in the region is coal. Workable beds occur both in the Lookout and in the Walden formations. The lower beds, those in the Lookout, are variable in position and thickness, so that, while they afford much excellent fuel in places, they are not generally suitable for working upon a large scale. Their character at Bon Air, where they are extensively developed, is exceptional. The most important coal seam in the region, by reason of its greater thickness and uniformity, is the Sewanee, which occurs in the Walden sandstone a short distance above the Lookout conglomerates. Its area, within the limits of the Pikeville quarter-degree, is about 500 square miles, of which the greater portion is workable.

FOLIO 22, MCMINNVILLE, TENNESSEE, 1895.

This folio, by Charles Willard Hayes, consists of 3 pages of text, a topographic sheet (scale 1:125,000), a sheet of areal geology, another showing the economic geology and another giving structure sections. Following the text is a generalized columnar section for the district, accompanied by vertical sections showing the position and thickness of coal beds.

The quarter-degree covered by the McMinnville folio has an area of 980 square miles. It joins the Pikeville and Sewanee quarter-degrees on the east and south. The greater part of its surface is within the highland rim. Its northwestern corner includes a small portion of the central basin of Middle Tennessee, and its southeastern corner is occupied by the Cumberland Plateau. From northwest to southeast, then, the surface rises by steps from the central basin, with an altitude of 700 feet, to the highland rim, at 1,000 feet, and again to the Cumberland Plateau at 1,800 feet. Each step or terrace is part of a more or less perfectly preserved peneplain produced by long-continued erosion, when the land stood relatively lower than now. The plateau, which is the highest and consequently the oldest of these plains, formerly extended far to the westward, but has been worn away by the action of streams during and since the formation of the next lower plain. In the same manner the streams are wearing down the second to the level of the third plain, and the escarpment which separates the two is slowly working backward toward the southeast, following the retreat of the higher plateau escarpment.

The McMinnville quarter-degree lies entirely beyond the westernmost of the sharp folds which characterize the Appalachian Valley belt. Its strata are nearly horizontal, having a very gentle and uniform dip toward the southeast of about 30 feet to the mile. The strata exposed measure only 1,700 feet in thickness, which is but a small fraction of the thickness exposed in regions containing folds. Of these 1,700 feet of strata, about 1,500 are Carboniferous, consisting of coal-measure sandstones and shales, forming the upper portion of the plateau, and limestones forming the lower portions of the plateau escarpments and the surface of the highland rim. Beneath the Carboniferous formations are from 10 to 30 feet of black shale, which appears to represent the whole of the Devonian deposition in this region. The streams in the northwestern corner of the quarter-degree have cut down through the Carboniferous and Devonian, and as much as 200 feet into the underlying Silurian limestone. The upper division of the Silurian on the

eastwardly adjacent Pikeville quarter-degree, the Rockwood shale, becomes so calcareous toward the west that it cannot be distinguished from the underlying Chickamauga limestone. The McMinnville quarter-degree is essentially an agricultural region, the Carboniferous limestones forming a belt of exceptionally fertile soil along the inner portion of the highland rim. It includes a small area of coal-bearing rocks in its southeastern corner, where the subconglomerate beds, probably corresponding to those at Bon Air, have been opened and worked for local consumption.

WORK OF THE UNITED STATES GEOLOGICAL SURVEY FOR FISCAL YEAR, 1896–97.

The Director of the U. S. Geological Survey recently formulated the plan of operations for the bureau under his charge for the fiscal year ending June 30, 1897, and it received the approval of the Secretary of the Interior. As soon as the plans were approved the surveying parties were made up and ordered to the field.

The plan covers all the work of the year, administrative and scientific, and begins with a financial statement. The total appropriation for topographic surveys for 1896–97 is $184,200, an increase of $25,000 over the appropriation for the year just closed. For geologic surveys and researches there is $118,700, which includes an item of $5,000, specifically appropriated for an investigation of the gold resources of Alaska, and for paleontologic work there is $14,000. For chemical researches the appropriation is the same as that for last year, $10,000. For hydrographic work there is an appropriatiou of $50,000, as against $20-000 for 1895–96. For the preparation of illustrations and of the report on mineral resources, the engraving of maps, etc., there is an aggregate appropriation of about $100,000.

In accordance with the plan 30 parties have taken the field or will soon take the field for geologic work, 5 in the New England region, including New York; 5 in the Appalachian region; 2 in the Atlantic Coastal Plain region; 5 in the Interior or Mississippi region; 4 in the Rocky Mountain region, and 8 in the Pacific region. The mining districts of the Appalachian and Rocky Mountain regions will receive special attention, though areal mapping and other work will go on in all directions, as heretofore.

The paleontologists will engage in the determination of faunas and floras, especially those of the coal regions of the Appalachians and Rocky Mountains, and a study will be made of the Cretaceous fauna of Colorado, Utah and Wyoming, with reference to areal and vertical distribution, for the purpose of aiding the geologists in the solution of problems in areal geology. For this work several of the paleontologists take the field.

The appropriation for hydrographic work has been subdivided, so that $25,000 will be devoted to the gauging of streams and the determination of the water supply of all parts of the country, a second sum of $10,-000 to the investigation of the subject of artesian wells and underground currents in arid and semi-arid regions, and the remainder to the preparation of reports upon the methods of utilizing the water resources. Work will be done in nearly every trans-Mississippi State and Territory, as well as in New England, Pennsylvania and most of the Southern States.

Topographic work this year will be under the immediate charge of the Director, and will thus be placed on the same footing in that respect with the geologic work. A highly important change will be in the method of making the topographic surveys, a change which will, it is expected, materially enhance the value and extend the field